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# **DER Equipment & Application**

Distributed Generation Code Workshop

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# Focus on Combined Heat and Power Technologies



# Combined Heat & Power (CHP)

## Definition:

Systems that use the same energy source for the simultaneous or sequential generation of electricity or mechanical shaft power (or both) and steam, hot water, and/or chilled water.



# The Center for Distributed Generation & Thermal Distribution

- ◆ What is it?
- ◆ Why was it formed?
- ◆ What do we hope to accomplish?
- ◆ What are we presently doing?



# CHP Systems

- Provides significant advantages in fuel use efficiency.
- Achieves a dramatic reduction in air emissions compared to conventional fossil fuel-fired generation of electricity.
- 60 to 80+ fuel use efficiency.
- US thermal electricity plants average 31-32% efficiency.

# CHP Systems (continued)

- On site generation avoids transmission and distribution loss and reinforces the transmission and distribution system.
- Can provide high quality reliable power.
- Offers cost savings, price stability and competitive advantage to those that install it.



# CHP may also introduce new equipment and fuels or fuel requirements into urban environments.

- ◆ Need for different approach to distribution of electricity and thermal energy and,
- ◆ New monitoring, operation and control technologies.

# Generation Technologies Include:

## Steam Turbines





# Generation Technologies (continued)

- **Internal Combustion Engines**
  - Industrial engines**



- Automotive-derived engines**



- Diesel engines**





# Generation Technologies (continued)

- Gas turbines

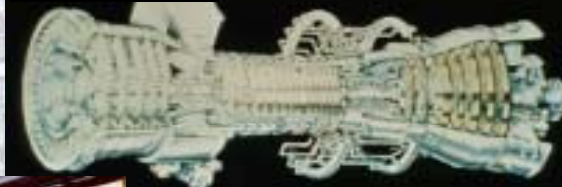
Microturbines  $< 1$  Mwe



Small gas turbines 1-10 Mwe



Large gas turbines  $> 10$  Mwe



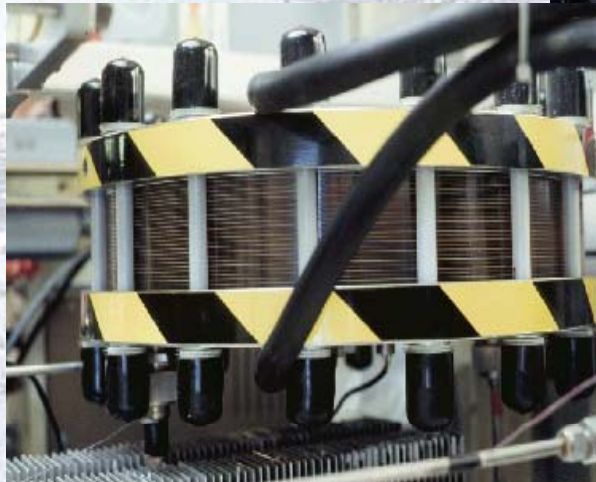
Aero-derivative





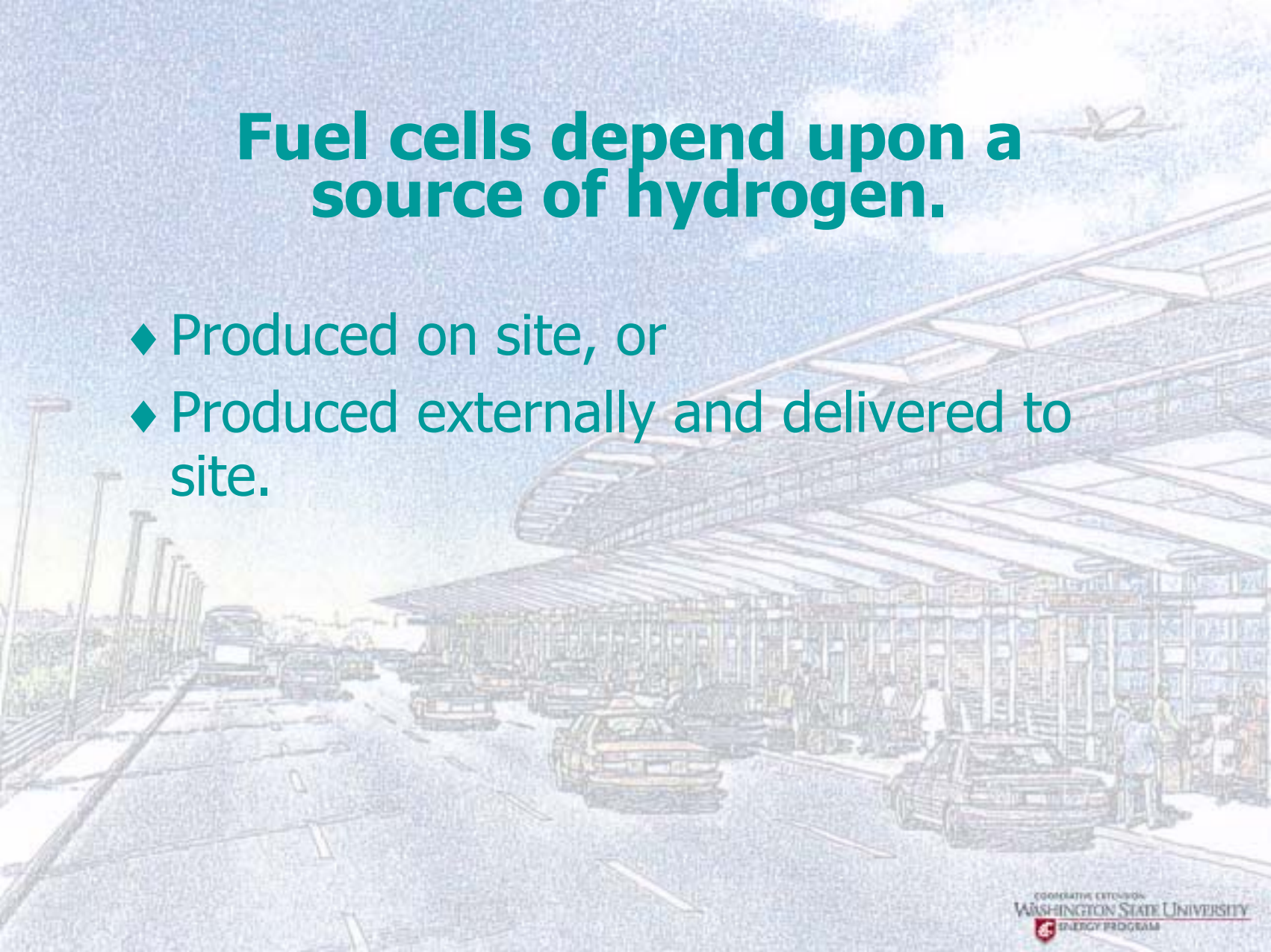
# Generation Technologies (continued)

## •Fuel Cells

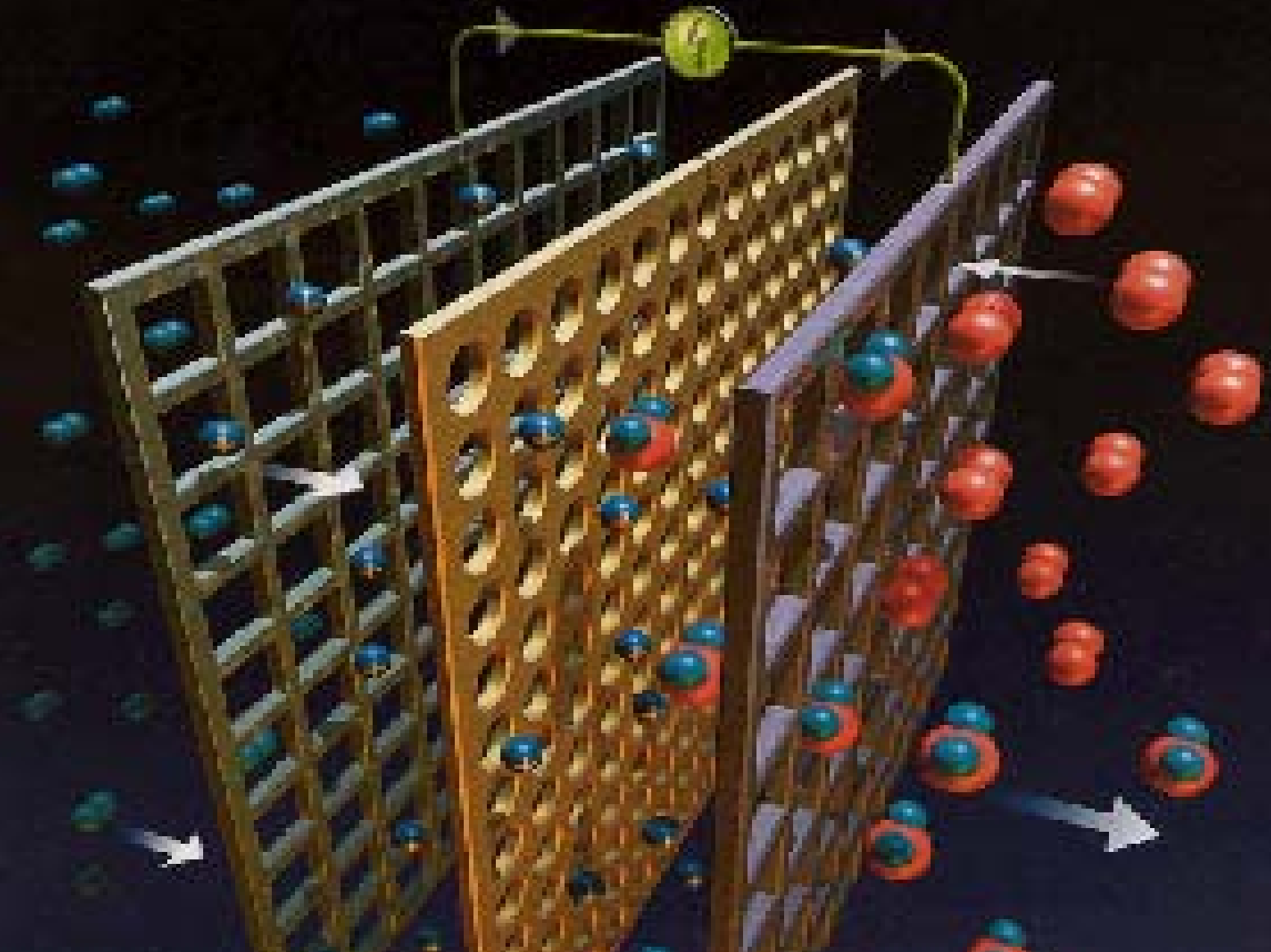


# Fuel cells depend upon a source of hydrogen.

- ◆ Produced on site, or
- ◆ Produced externally and delivered to site.

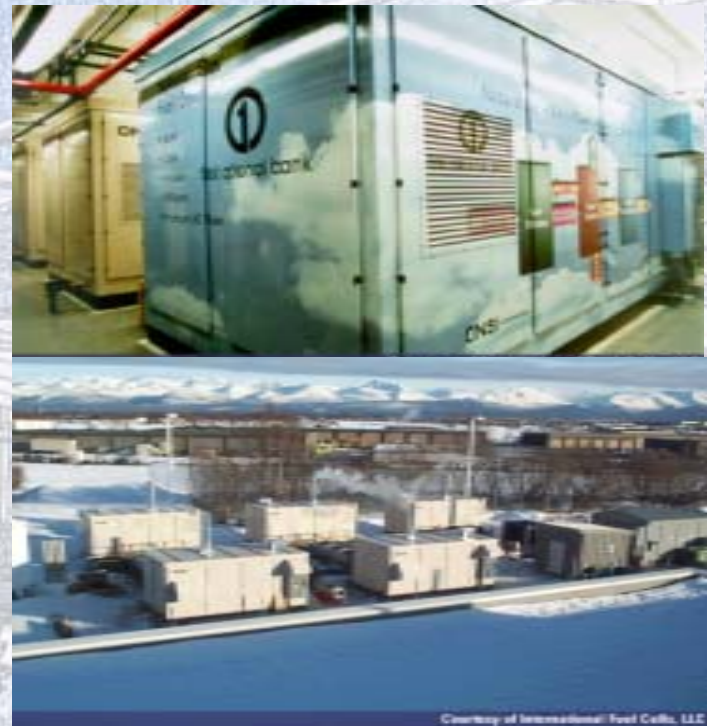






# Fuel Cell Phosphoric Acid

- IFC is the only company producing fuel cell systems for use commercially (phosphoric acid).
- Delivered more than 200 of our 200-kilowatt fuel cell systems throughout the U.S. and in 15 countries.





# Molten Carbonate Fuel Cell

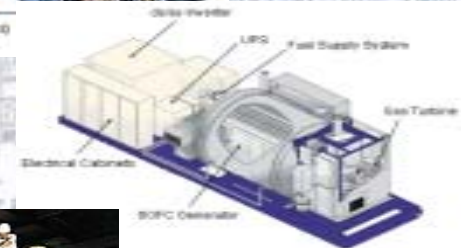
- FuelCell Energy is developing its Direct FuelCell® (DFC®) for use in stationary applications. The three main products—a 300 kW, a 1.5 MW and a 3 MW—are designed to meet a variety of applications.
- For example, the 300 kW single stack DFC power plant is a skid-mounted, compact unit, that can be used to add incremental capacity or to gain operational familiarity with DFC power plants. Ideal customers include light industrial, small buildings, and other applications requiring 250 kW to 1 MW of power.



# Solid Oxide Fuel Cell

First deliveries being made in 2004. Market entry products will serve the distributed generation segment of the all-electric and the generation/ cogeneration markets in the range ~0.3-5 MW.

220-kW hybrid system with a Solid Oxide Fuel Cell (SOFC) generator and a down-stream micro hot-gas turbine.





# Generation Technologies (continued)

## Stirling Engine

**This 25-kW external combustion system uniquely combines a state-of-the-art engine, generator, power electronics, control and remote monitoring technologies. Proprietary, four-cylinder heat engine technology from STM Power Inc. can utilize heat from virtually any source and turn it into efficient electric power.**



# Electrical Storage

Concerns about reliability and power quality.

- High-tech firms are required 7, 8 or 9 nines of electric system reliability.
- High-tech commercial and industrial components require technologies to condition power against voltage spikes and surges—the so-called clean nines.
- Technologies include compressed air storage, fly wheels, motor generators, and batteries.



# Heat Recovery

- Steam extraction
- Steam or hot water production-HRSG
- Supplemental firing
  - Back up
  - Peaking



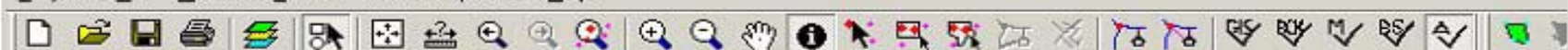
# Heat Storage

- Hot water
- Oil/rock
- Molten salt





# Thermal Distribution



☒ VALVES

☒ NODES (Level)

- Less than 25
- 25 - 29
- 30 - 33
- 34 - 38
- 39 - 42
- 43 - 47
- 48 - 51
- 52 - 55
- 56 - 60
- 61 - 64
- 65 - 69
- 70 - 73
- Greater than 74

☒ LEVELS

☒ PIPES (Diameter)

- ▬ Less than 41
- ▬ 41 - 71
- ▬ 72 - 102
- ▬ 103 - 133
- ▬ 134 - 165
- ▬ 166 - 196
- ▬ 197 - 227
- ▬ 228 - 258
- ▬ 259 - 290
- ▬ 291 - 321
- ▬ 322 - 352
- ▬ 353 - 383
- ▬ Greater than 384

☒ DEMANDS (Demand)

- Less than 1,200
- 1,200 - 2,072
- 2,073 - 2,944

Thermal distribution can be in the form of hot water or steam.



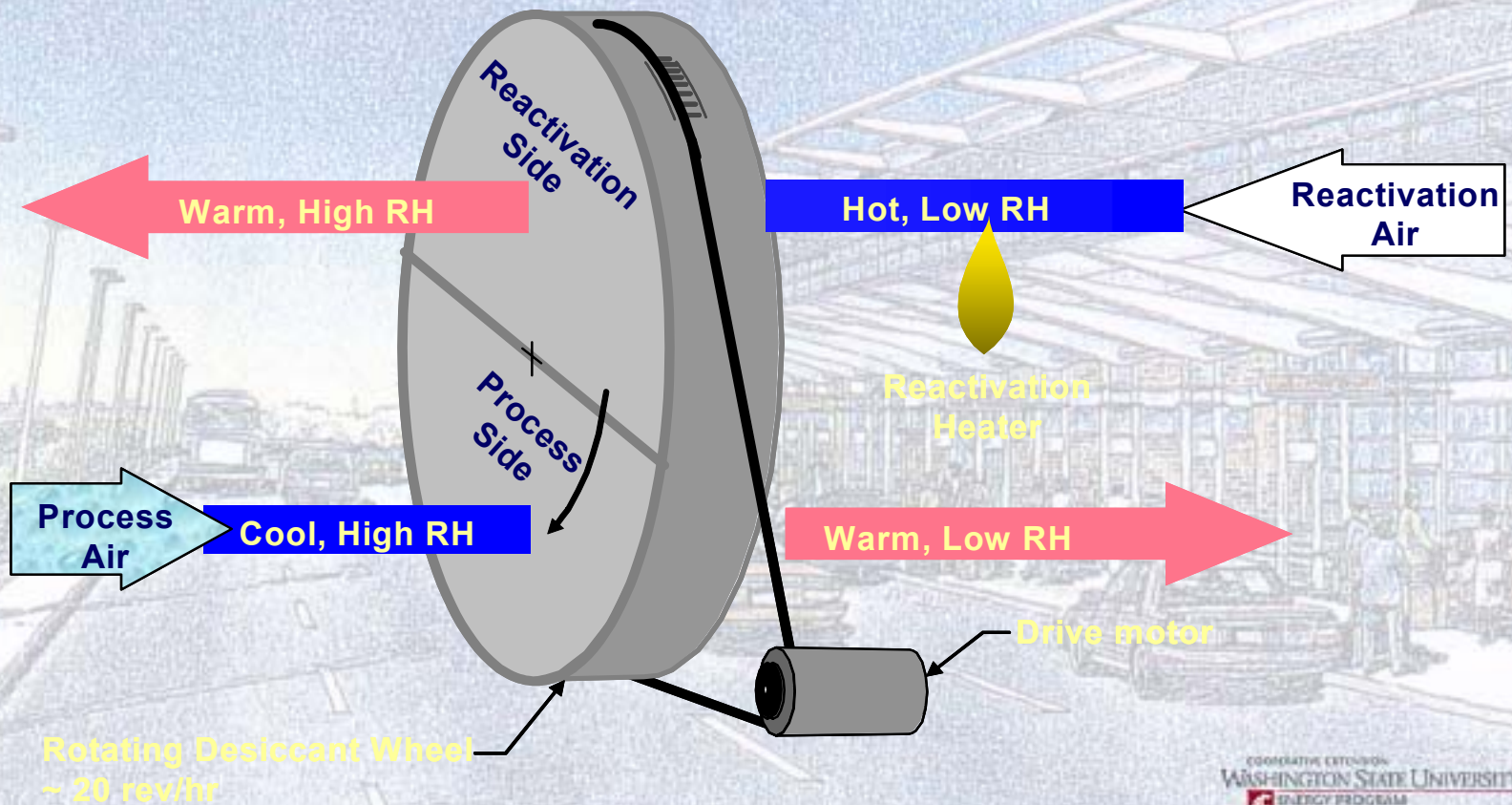


# Cooling Technologies Based on Heat Extraction

- Steam driven chillers
- Absorption / adsorption chillers
- Desiccant dehumidification



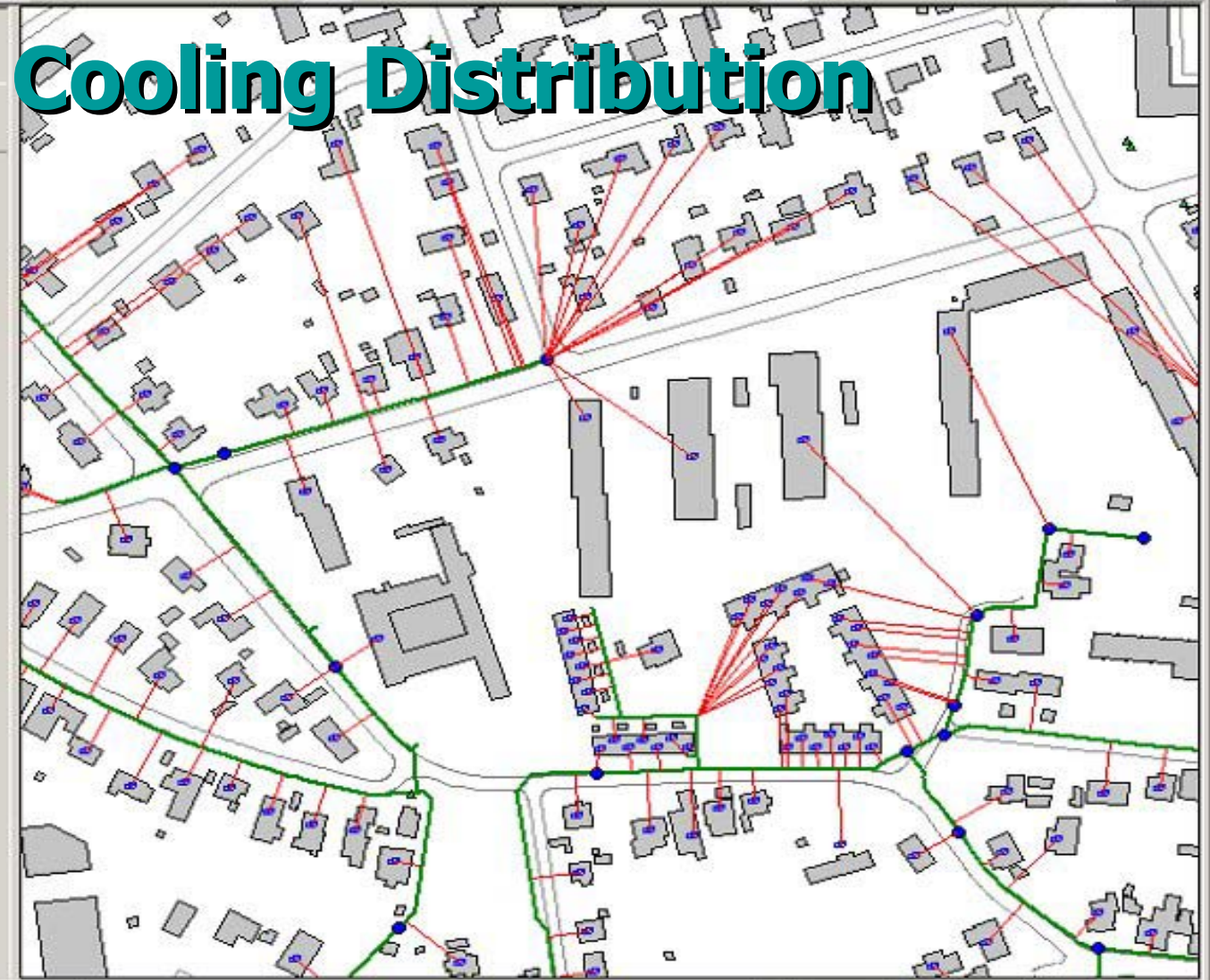
# Desiccant Technology







- ☒ VALVES
- ☒ NODES
- ☒ LEVELS
- ☒ PIPES
- ☒ DEMANDS
- ☒ [BCK]STREETS
- ☒ [BCK]BUILDINGS
- ☐ DEMANDZONES



# Thermal Storage Cooling

- Chilled Water

- Brine

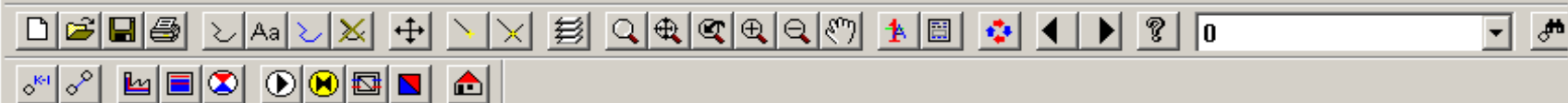
- Ice Slurry

- Ice

- Eutectic salt







# Computer Operation & Control

Heat loss - supply [W/m]

Time : 00-06:32

	60.02 -	*
	52.40 -	60.02
	44.78 -	52.40
	37.15 -	44.78
	29.53 -	37.15
	21.91 -	29.53
	14.29 -	21.91
	6.67 -	14.29
	*	6.67



# Applications

## •Industrial Facilities





# Applications (continued)

- Institutional Complexes
- Colleges and universities
- Commercial parks



# Applications (continued)

- Hospitals
- Military installations
- Correctional facilities





# Applications (continued)

- **Municipal District Energy Systems**



# Applications (continued)

- Commercial Buildings

- Banks



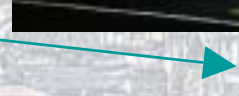
- Credit card processing centers



- Law and justice centers



- Medical clinics



- Etc.

